Chemistry 1220 Practice problems – Exam 2 (Chapter 16 -17)

DO NOT ONLY study these problems for your EXAM. You are responsible for everything else that was discussed in class and text.

Question I: ***Multiple choices:*** Choose one best answer for each of the following question below

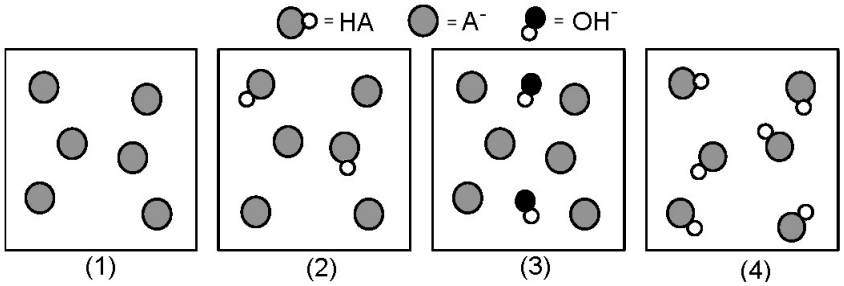
1. The equilibrium constant, *K*, for the reaction shown below has a value 1.8×10^{-5}. In this reaction which is the strongest acid and which is the strongest base?

$$CH_3CO_2H(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + CH_3CO_2^-(aq)$$

A) CH_3CO_2H and $CH_3CO_2^-$ B) CH_3CO_2H and H_2O

C) H_3O^+ and H_2O **D) H_3O^+ and $CH_3CO_2^-$**

2. The following pictures represent solutions at various points in the titration of a weak acid HA with aqueous KOH. Unshaded spheres represent H atoms, black spheres represent oxygen atoms, and shaded spheres represent A^- ions. (K^+, H_3O^+ initially present, OH^- initially present and solvent water molecules have been omitted for clarity).



Which picture represents the solution at the equivalence point?

A) (1) B) (2)

C) (3) D) (4)

2. Which is a net ionic equation for the neutralization of a weak acid with a strong base?

A) $HCl(aq) + NaOH(aq) \rightleftharpoons H_2O(l) + NaCl(aq)$

B) $H_3O^+(aq) + OH\text{-}(aq) \rightleftharpoons 2\ H_2O(l)$

C) $HF(aq) + NaOH(aq) \rightleftharpoons H_2O(l) + NaF(aq)$

D) $HF(aq) + OH\text{-}(aq) \rightleftharpoons H_2O(l) + F\text{-}(aq)$

3. If the pKa of $HCHO_2$ is 3.74 and the pH of an $HCHO_2/NaCHO_2$ solution is 3.89, which of the following is TRUE?

A) $[HCHO_2] < [NaCHO_2]$ B) $[HCHO_2] = [NaCHO_2]$

C) $[HCHO_2] > [NaCHO_2]$ D) $[HCHO_2] >> [NaCHO_2]$

4. An important buffer in the blood is a mixture of _____.
A) sodium chloride and hydrochloric acid
B) hydrochloric acid and sodium hydroxide
C) carbonic acid and bicarbonate ion
D) acetic acid and bicarbonate ion
E) acetic acid and carbonate ion

5. Which one of the following salts, when dissolved in water, produces the solution with the **highest** pH?
A) $KHSO_4$ B) $RbClO_4$
C) BaO D) $CH_3CH_3NH_3Br$

6. Identify the strongest acid.
A) HFO_4 B) HFO_3
C) HFO_2 D) HFO E) Not enough information is given.

7. Determine the pH of a 0.023 M HNO_3 solution.
A) 12.36 B) 3.68
C) 1.64 D) 2.30
E) 2.49

8. Which is the best acid to use in the preparation of a buffer with pH = 3.3?

A) HOI ($K_a = 2.0 \times 10^{-11}$) **B) HNO_2 ($K_a = 4.5 \times 10^{-4}$)**

C) HNO_3 D) HIO_3 ($K_a = 1.7 \times 10^{-1}$)

9. Sodium hypochlorite, NaOCl, is the active ingredient in household bleach. What is the concentration of hypochorite ion if 20.00 mL of bleach requires 28.30 mL of 0.500 M HCl to reach the equivalence point?

A) 0.208 M B) 0.353 M

C) 0.708 M D) 1.21 M

10. Which of the following is TRUE?
A) An effective buffer has a [base]/[acid] ratio in the range of 10 - 100.
B) A buffer is most resistant to pH change when [acid] = [conjugate base]
C) An effective buffer has very small absolute concentrations of acid and conjugate base.
D) A buffer can not be destroyed by adding too much strong base. It can only be destroyed by adding too much strong acid.
E) None of the above are true.

11. Which of the following is TRUE?
A) The equivalence point is where the amount of acid equals the amount of base during any acid-base titration.
B) At the equivalence point, the pH is always 7.
C) An indicator is not pH sensitive.
D) A titration curve is a plot of pH vs. the [base]/[acid] ratio.
E) None of the above are true.

Question II

1. Sketch the titration curve for a C_5H_5N versus HBr. Make sure to indicate the equivalence point (and whether it is acidic, basic or neutral) and the buffer region.

2. Explain why the pH at the equivalence point is less than 7.00 for weak base and strong acid

3. What is percent ionization of an acid? Explain what happens to percent ionization of a weak acid as a function of concentration of the weak acid solution.

4. identify the Lewis acid and the Lewis base. Explain your answer by showing a complete Dot Lewis structure for the two reactants.

$AlCl_3 + Cl^- \rightarrow AlCl_4$

Acid **Base** **Draw Dots Lewis structure for each**

5. Classify each of the following salt solutions as neutral, acidic or basic. Explain your answer by showing a hydrolysis equation for each ion. Write NR for those that do not hydrolyze in water.

Salt	pH cation > 7.00, < 7.00 or = 7.00	pH anion > 7.00, < 7.00 or = 7.00	pH salt
KI			**neutral**
$C_6H_5NH_3NO_2$			**Acidic** **$K_a > K_b$**
K_2CO_3			**Basic**

Question III

1. Calculate the pH of a 1.60 M CH_3NH_3Cl solution. K_b for methylamine, CH_3NH_2, is 3.7×10^{-4}.

pH = 5.18

2. a. What is the pH of a 150.0 ml buffer of 0.10 M Na_2HPO_4/0.15 KH_2PO_4? Do not use Henderson Hassalbalch equation. $Ka_2 = 6.2 \times 10^{-8}$

pH = 7.02

b. What is the new pH of the buffer after adding 10.5 ml of 0.10M KOH. Assume the volume is additive). Neutralization reaction must be shown and you can use Henderson Hassalbalch to solve for the new pH

pH = 7.09

3. A solution is prepared by dissolving 0.535 g of NH_4Cl in 250.0 ml of 0.080 M NH_3.
   a. Calculate the pH of the above mixture. $K_b = 1.8 \times 10^{-5}$

   pH = 9.56

b. Would the pH increase or decrease if the solution is disturbed by adding HBr? Using Henderson-Hasselbalch to explain the changes

   decreases

4. Calculate how much HCl must be added to a liter of buffer that is 1.5 M in acetic acid and 0.75M in sodium acetate to result in a buffer pH of 4.10? Ka = 1.8×10^{-5}

12.0g

5. What is the percent dissociation of ascorbic acid if the solution has a pH = 5.50 and a pK_a = 4.10?

96%

8. Formic acid (HCO_2H, $K_a = 1.8 \times 10^{-4}$) is the principal component in the venom of stinging ants.

a. What is the molarity of a formic acid solution if 25.00 mL of the formic acid solution requires 29.80 mL of 0.0567 M NaOH to reach the equivalence point?

Answer: 0.0676 M

b. Calculate the pH after 40.0 mL of NaOH was added?

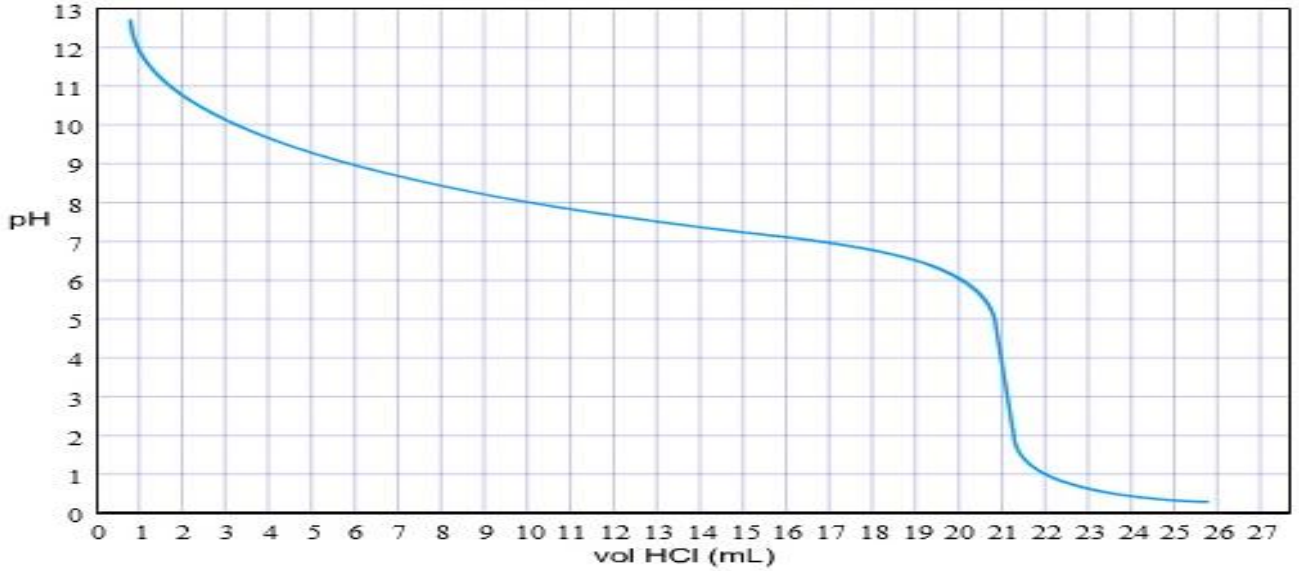
Answer: 11.95

9. What is the pH of the resulting solution if 40.0 mL of 0.432 M methylamine, CH_3NH_2, is added to 15.0mL of 0.234 M HCl? Assume that the volumes of the solutions are additive. $K_a = 2.70 \times 10^{-11}$ for $CH_3NH_3^+$.

Answer: 11.16

10. Consider the titration curve below

A 25.00 mL of an unknown weak base solution is titrated again 0.100M HCl solution. Using the titration curve below to answer the following questions. Report your answers to one decimal place and don't forget to show all your work



a. (2pts) What is the volume (ml) of titrant at the equivalence point?

b. (3pts) Determine the concentration of unknown weak base

c. (4pts) What is the K_b of this unknown weak base?